NeuroGuard ECE 445 Project

Senior Design Team Goals

A. Design and simulate a circuit (potentially iterating upon current version) that demonstrates ability to switch between predefined electrocautery and nerve stimulation waveforms at specified time intervals
    a. uses the high-voltage electrosurgical unit (ESU) as the original power source
B. Prototype circuit from Part A. that can be integrated with an electrosurgical unit and standard monopolar electrocautery probe

The ECE 445 students are primarily responsible for building out the circuitry, while the NeuroGuard team will focus on clinical interfacing and testing the nerve stimulation properties.

Current circuit iteration (submitted to IEEE NER 2025)

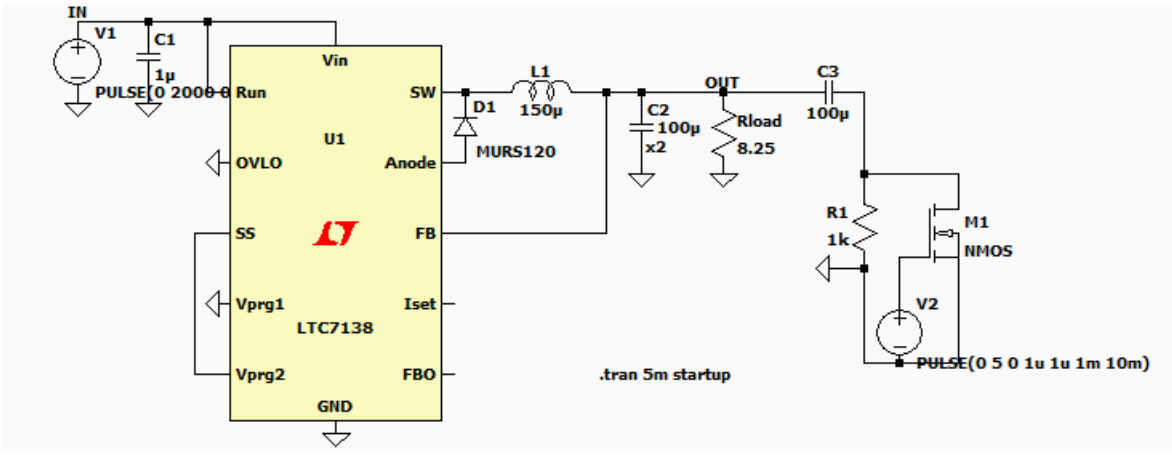

Figure 1. Current circuit design consists of buck converter (Integrated Circuit LTC7138, Analog Devices), capacitor bank, and MOSFET switch.

The duty cycle modification circuit was designed via the simulation software LTspice to meet several goals: 1) high voltage step down; 2) energy storage and discharge; 3) controlled nerve stimulation. The configuration (Fig. 1) integrates a buck converter, capacitor bank, and MOSFET switch. The buck converter (IC: LTC7138, Analog Devices) steps down high-voltage input (such as from an ESU) to a stable 5V output, which charges a capacitor bank designed for rapid discharge.

A capacitor value (C3) in the range of 47–220 µF provides sufficient energy to deliver short, low-current pulses. The stored energy is selectively discharged through a 1kΩ resistor (simulating nerve tissue) via an

N-channel MOSFET, whose gate is driven by a 5V pulse signal (from a microcontroller or pulse source). The gate is connected through a 100Ω resistor and pulled down to ground with a 10kΩ resistor to prevent floating states. When the gate receives a high signal, the MOSFET turns on, allowing the capacitor to release its energy as a precise stimulation pulse across the load.

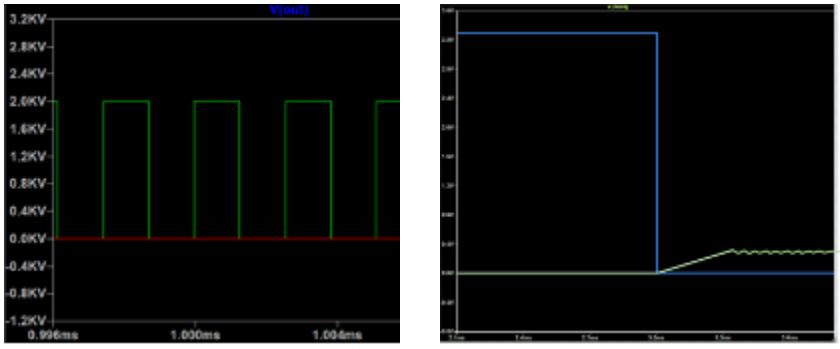

Figure 2AB. (A) Simulation output in LTspice, demonstrating ability to switch between electrocautery voltage (2000V) and smaller nerve stimulation waveform. (B) Adjustment of original circuit (Vin=3.3V, C3=200uF) to improve visualization of precise capacitor discharge timing.

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